

8. REGULATIONS AND ADVISORIES

International and national guidelines and state regulations regarding exposure to stable cobalt and its compounds are summarized in Table 8-1. The regulations regarding radioactive cobalt are summarized in Table 8-2.

Stable Cobalt. An MRL of 1×10^{-4} mg cobalt/m³ has been derived for chronic-duration inhalation exposure. The MRL is based on a NOAEL of 0.0053 mg cobalt/m³ for decreased respiratory function in exposed workers (Nemery et al. 1992). An MRL of 1×10^{-2} mg/kg-day has been derived for intermediate-duration oral exposure, based on a LOAEL of 1 mg/kg-day for polycythemia in human volunteers (Davis and Fields 1958). No other inhalation or oral MRLs were derived.

The EPA has not derived an RfC or RfD for cobalt and compounds. Similarly, no cancer classification has been performed by the EPA (IRIS 2000). The American Conference of Governmental Industrial Hygienists (ACGIH) has given cobalt a classification of A3, Confirmed Animal Carcinogen with Unknown Relevance to Humans, and established an 8-hour time-weighted average (TWA) of 0.02 mg/m³ for occupational exposure (ACGIH 1999). The Occupational Safety and Health Administration (OSHA) has promulgated an 8-hour Permissible Exposure Limit (PEL) of 0.1 mg/m³ (OSHA 1993), and the National Institute for Occupational Safety and Health (NIOSH) recommends an 8-hour TWA of 0.05 mg/m³ (NIOSH 2000). IARC (1991) reports that cobalt and cobalt compounds are possibly carcinogenic to humans (group 2B), based on sufficient evidence for cobalt metal and cobalt oxides and limited evidence for cobalt chloride and cobalt sulfate.

Cobalt and its compounds are regulated by the Clean Water Effluent Guidelines for the following industrial point sources: nonferrous metal manufacturing, asbestos, timber products processing, paving and roofing, paint formulating, ink formulating, gum and wood, carbon black, and battery manufacturing (EPA 1988).

Radioactive Cobalt. No MRLs were derived for inhalation or oral exposure to radioactive cobalt. MRLs for acute and chronic exposure to ionizing radiation exist (ATSDR 1999) and are applicable to cobalt. The EPA has not derived an RfC or RfD for radioactive cobalt (IRIS 2000). Slope factors have been derived for exposure to cobalt radioisotopes (EPA 1997). The slope factors for ⁶⁰Co are 1.89×10^{-11} /pCi for ingestion, 6.88×10^{-11} /pCi for inhalation exposure, and 9.76×10^{-6} /year/pCi/g soil for external exposure.

8. REGULATIONS AND ADVISORIES

The slope factors for ^{58}Co are $2.82 \times 10^{-12}/\text{pCi}$ for ingestion, $5.17 \times 10^{-12}/\text{pCi}$ for inhalation exposure, and $3.73 \times 10^{-6}/\text{year/pCi/g soil}$ for external exposure, and the slope factors for $^{58\text{m}}\text{Co}$ are $9.46 \times 10^{-14}/\text{pCi}$ for ingestion, $8.90 \times 10^{-14}/\text{pCi}$ for inhalation exposure, and $3.21 \times 10^{-11}/\text{year/pCi/g soil}$ for external exposure. For ^{57}Co , the slope factors are $9.71 \times 10^{-13}/\text{pCi}$ for ingestion, $2.88 \times 10^{-12}/\text{pCi}$ for inhalation exposure, and $2.07 \times 10^{-7}/\text{year/pCi/g soil}$ for external exposure.

8. REGULATIONS AND ADVISORIES

Table 8-1. Regulations and Guidelines Applicable to Stable Cobalt

Agency	Description	Information	Reference
<u>INTERNATIONAL</u> Guidelines:			
IARC	Carcinogenicity classification Cobalt and cobalt compounds ^a	Group 2B ^b	IARC 2001b
<u>NATIONAL</u> Regulations and Guidelines:			
a. Air			
ACGIH	TLV-TWA Cobalt, elemental, and inorganic compounds (as Co)	0.02 mg/m ³	ACGIH 2000
NIOSH	REL (TWA) Cobalt metal, dust, and fumes (as Co)	0.05 mg/m ³	NIOSH 2001
	IDLH Cobalt metal, dust, and fumes (as Co)	20 mg/m ³	
OSHA	PEL (8-hour TWA) General industry Cobalt metal, dust, and fumes (as Co)	0.1 mg/m ³	OSHA 2001e 29CFR1910.1000 Table Z
	PEL (8-hour TWA) Construction industry Cobalt metal, dust, and fumes (as Co)	0.1 mg/m ³	OSHA 2001d 29CFR1926.55
	PEL (8-hour TWA) Shipyards industry Cobalt metal, dust, and fumes (as Co)	0.1 mg/m ³	OSHA 2001c 29CFR1915.1000
USC	HAP Cobalt compounds		USC 2001a 42USC7412
b. Water			
EPA	NPDES permit application testing requirements —conventional and nonconventional pollutants required to be tested by existing dischargers if expected to be present		EPA 2001g 40CFR122 Appendix D Table IV

8. REGULATIONS AND ADVISORIES

Table 8-1. Regulations and Guidelines Applicable to Stable Cobalt (*continued*)

Agency	Description	Information		Reference
NATIONAL (cont.)				
EPA	BPT effluent limitations			EPA 2001b
	Maximum for 1 day	3x10 ⁻⁴ kg/kkg		40CFR415.652
	Average of daily values for 30 consecutive days	1.2x10 ⁻⁴ kg/kkg		
	Groundwater monitoring	Suggested method	PQL	EPA 2001d
		6010	70 µg/L	40CFR264
		7200	500 µg/L	Appendix IX
		7201	10 µg/L	
c. Food				
FDA	Drug products withdrawn or removed from the market for reasons of safety or effectiveness	All drug products containing cobalt salts (except radioactive forms of cobalt and its salts and cobalamin and its derivatives)		FDA 2000a 21CFR216.24
	New drug status accorded through rulemaking procedures	Cobalt preparations intended for use by man		FDA 2000b 21CFR310.502 (a)(7)
	Over-the-counter drugs; recommended warning and caution statement Cobalt as a cobalt salt	Required on articles containing \$0.5 µg per dose and \$2 µg per 24-hour period		FDA 2000e 21CFR369.20
	Substances generally recognized as safe—trace minerals added to animal feeds	Cobalt acetate Cobalt carbonate Cobalt chloride Cobalt oxide Cobalt sulfate		FDA 2000f 21CFR582.20
	Substances prohibited from use in human food	Cobaltous salts and its derivatives		FDA 2000g 21CFR189.120
d. Other				
ACGIH	Carcinogenicity classification Cobalt, elemental, and inorganic compounds (as Co)	A3 ^c		ACGIH 2000
	BEI			
	Cobalt in urine—end of shift at end of workweek	15 µg/L		
	Cobalt in blood—end of shift at end of workweek	1 µg/L		

8. REGULATIONS AND ADVISORIES

Table 8-1. Regulations and Guidelines Applicable to Stable Cobalt (*continued*)

Agency	Description	Information		Reference
<u>NATIONAL</u> (cont.)				
EPA	RfC	No data		IRIS 2000
	RfD			
	Carcinogenicity classification			
	Toxic chemical release reporting; Community Right-to-Know—effective date	01/01/87		EPA 2001c 40CFR372.65(a)
	Hazardous waste—identification and listing	Contain #1 ppmv in synthesis gas fuel generated from hazardous waste		EPA 2001e 40CFR261.38 (b)(5)
	TSCA—health and safety data reporting			EPA 2001j 40CFR716.120
	Municipal solid waste landfills—hazardous constituent for detection monitoring	Suggested <u>method</u> 6010 7200 7201	<u>PQL</u> 70 µg/L 500 µg/L 10 µg/L	EPA 2001f 40CFR258 Appendix I and II
	Reportable quantity Cobalt compounds	1 pound		EPA 2001h 40CFR302.4
USC	Superfund imposition of tax on cobalt	\$4.45 per ton		USC 2001c 26USC4661
	Exemption of tax imposed on recycled cobalt			USC 2001b 26USC4662
<u>STATE</u>				
a. Air				
Alabama	HAP Cobalt compounds			BNA 2001
Alaska	Air contaminant standard TWA Cobalt metal, dust, and fumes	0.05 mg/m ³		BNA 2001
California	Airborne contaminant Cobalt metal, dust, and fumes			BNA 2001
	HAP Cobalt compounds			BNA 2001
	Toxic air contaminant Cobalt compounds			CA Air Resources Board 2000

8. REGULATIONS AND ADVISORIES

Table 8-1. Regulations and Guidelines Applicable to Stable Cobalt (*continued*)

Agency	Description	Information	Reference
<u>STATE (cont.)</u>			
Colorado	HAP Cobalt metal, dust, and fumes		BNA 2001
	“High-concern” pollutant Cobalt (and compounds)		BNA 2001
	Reportable pollutants Cobalt metal, dust, and fumes		CO Dept. of Public Health and Environment 2000
Connecticut	HAP—hazard limiting value Cobalt metal, dust, and fumes		BNA 2001
	8 hours 30 minutes	2 µg/m ³ 10 µg/m ³	
Delaware	Reportable quantities		DE Air Quality Management 2000
	Cobalt carbonyl	1 pound	
	Cobaltous sulfamate	1,000 pounds	
	Cobalt, ((2,2'-(ethane diylbis(nitrilomethylidyne)	1 pound	
Hawaii	Air contaminant limit PEL-TWA		BNA 2001
	Cobalt metal, dust, and fumes	0.05 mg/m ³	
Idaho	HAP Cobalt compounds		BNA 2001
	TAP non-carcinogenic increments		ID Dept. of Environmental Quality 2000
	Cobalt carbonyl and cobalt hydrocarbonyl (as Co)		
	OEL	1x10 ⁻¹ mg/m ³	
	EL	7x10 ⁻³ pounds/hour	
	AAC (24-hour average)	5x10 ⁻³ mg/m ³	
	Cobalt metal, dust, and fumes		
	OEL	5x10 ⁻² mg/m ³	
Illinois	Toxic air contaminant Cobalt		IL EPA 2000a
Kansas	HAP Cobalt compounds		KS Dept. of Health and Environment 2000
Kentucky	HAP Cobalt compounds		BNA 2001

8. REGULATIONS AND ADVISORIES

Table 8-1. Regulations and Guidelines Applicable to Stable Cobalt (*continued*)

Agency	Description	Information	Reference
<u>STATE</u> (<i>cont.</i>)			
Louisiana	Toxic air pollutant Cobalt compounds		BNA 2001
Maine	Emissions standards	2,000 pounds	BNA 2001
Maryland	Toxic air pollutant Cobalt compounds		BNA 2001
Michigan	High concern toxic air pollutants Cobalt compounds		BNA 2001
Minnesota	HAP threshold Cobalt metal and cobalt carbonyl	0.1 tons/year	BNA 2001
Missouri	HAP Cobalt compounds		BNA 2001
Montana	Occupational air contaminant Cobalt metal, dust, and fumes	0.1 mg/m ³	BNA 2001
Nebraska	HAP Cobalt compounds and cobalt		BNA 2001
New Mexico	Toxic air pollutant Cobalt metal, dust, and fumes (as Co) OEL Emissions	1x10 ⁻¹ mg/m ³ 6.67x10 ⁻³ pounds/hour	BNA 2001
New York	Annual guideline concentrations	5x10 ⁻³ µg/m ³	NYS Dept. of Environmental Conservation 2000
	Dangerous air contaminants TLV Cobalt metal, dust, and fumes	0.1 mg/m ³	BNA 2001
	HAP Cobalt compounds		BNA 2001
	Transition limits PEL Cobalt metal, dust, and fumes	0.1 mg/m ³	BNA 2001
	Final rule limits TWA Cobalt metal, dust, and fumes	0.05 mg/m ³	

8. REGULATIONS AND ADVISORIES

Table 8-1. Regulations and Guidelines Applicable to Stable Cobalt (*continued*)

Agency	Description	Information	Reference
STATE (<i>cont.</i>)			
North Carolina	PEL-TWA Cobalt metal, dust, and fumes	0.05 mg/m ³	BNA 2001
Ohio	TRI		Ohio EPA 2000
Oregon	Air contaminant Cobalt metal, dust, and fumes	0.1 mg/m ³	BNA 2001
Rhode Island	HAP Cobalt compounds		BNA 2001
South Carolina	Toxic air emissions—MAC Cobalt compounds	0.25 µg/m ³	BNA 2001
Texas	HAP Cobalt metal, dust, and fumes	0.1 mg/m ³	BNA 2001
Vermont	HAP Cobalt compounds		BNA 2001
	Hazardous ambient air standards Cobalt compounds Annual average Averaging time Action level	0.12 µg/m ³ 24 hours 6.2x10 ⁻³ pounds/8 hours	BNA 2001
Washington	Class B TAP and ASIL (24-hour average) Cobalt metal, dust and fumes Cobalt carbonyl and cobalt hydrocarbonyl	0.17 µg/m ³ 0.33 µg/m ³	WA Dept. of Ecology 2000
	Thresholds for HAPs Cobalt carbonyl Cobalt metal, dust, and fumes	0.1 tons/year 0.1 tons/year	BNA 2001
Wisconsin	HAP—existing sources AAC <25 feet AAC ≥25 feet	4.08x10 ⁻³ pounds/hour 1.704x10 ⁻² pounds/hour	WI Dept. of Natural Resources 1999
b. Water			
Alabama	Groundwater monitoring Cobalt	Suggested methods 6010 7200 7201	BNA 2001
		PQL 70 µg/L 500 µg/L 10 µg/L	
Arizona	Drinking water guideline	0.70 µg/L	FSTRAC 1999

8. REGULATIONS AND ADVISORIES

Table 8-1. Regulations and Guidelines Applicable to Stable Cobalt (*continued*)

Agency	Description	Information		Reference
STATE (cont.)				
Arkansas	Groundwater monitoring Cobalt	Suggested methods 6010 7200 7201	PQL 70 µg/L 500 µg/L 10 µg/L	BNA 2001
California	Chemicals known to cause cancer or reproductive toxicity —date of initial appearance on the list Cobalt metal powder Cobalt[II] oxide Cobalt sulfate hepta-hydrate	07/01/92 07/01/92 06/02/00		CA EPA 2000
Colorado	Groundwater standard Cobalt	0.05 mg/L		BNA 2001
Delaware	Groundwater monitoring Cobalt	Suggested methods 6010 7200 7201	PQL 70 µg/L 500 µg/L 10 µg/L	BNA 2001
Illinois	Groundwater quality standards for Class II	1 mg/L		IL EPA 2000b
Kentucky	Hazardous waste constituent for groundwater monitoring Cobalt			BNA 2001
Louisiana	Groundwater monitoring Cobalt	Suggested methods 6010 7200 7201	PQL 70 µg/L 500 µg/L 10 µg/L	BNA 2001
Massachusetts	Groundwater monitoring Cobalt	Suggested methods 6010 7200 7201	PQL 70 µg/L 500 µg/L 10 µg/L	BNA 2001
Minnesota	Drinking water guideline Groundwater protection hazardous constituent Cobalt (total)	2 µg/L		FSTRAC 1995 BNA 2001
Missouri	Water quality standards Livestock, wildlife watering Groundwater	1x10 ³ µg/L 1x10 ³ µg/L		BNA 2001

8. REGULATIONS AND ADVISORIES

Table 8-1. Regulations and Guidelines Applicable to Stable Cobalt (*continued*)

Agency	Description	Information		Reference
STATE (cont.)				
New Mexico	Standards for groundwater of 10,000 mg/L TDS concentration or less Cobalt	0.05 mg/L		BNA 2001
New York	Groundwater monitoring Cobalt	Suggested methods 6010 7200 7201	PQL 70 µg/L 500 µg/L 10 µg/L	BNA 2001
Tennessee	Effluent limitations—daily maximum concentration Cobalt	10 mg/L		BNA 2001
Wisconsin	Drinking water guideline	40 µg/L		FSTRAC 1999
	Groundwater standards Cobalt			BNA 2001
	Enforcement standard Preventive action limit	40 µg/L 8 µg/L		
c. Food		No data		
d. Other				
Alabama	Detection limit values for comparable fuel specification Cobalt			BNA 2001
	Concentration limit	4.6 mg/kg at 10,000 BTU/pound		
Arizona	Soil remediation levels Cobalt			BNA 2001
	Residential Non-residential	4.6x10 ³ mg/kg 9.7x10 ⁴ mg/kg		
Arkansas	Detection limit values for comparable fuel specification Cobalt			BNA 2001
	Concentration limit	4.6 mg/kg at 10,000 BTU/pound		
	Solid waste management Cobalt	Suggested methods 6010 7200 7201	PQL 70 µg/L 500 µg/L 10 µg/L	BNA 2001

8. REGULATIONS AND ADVISORIES

Table 8-1. Regulations and Guidelines Applicable to Stable Cobalt (*continued*)

Agency	Description	Information	Reference
<u>STATE (cont.)</u>			
California	Characteristics of toxicity Cobalt and cobalt compounds		BNA 2001
	STLC	80 mg/L	
	TTLIC	8,000 mg/kg (wet-weight)	
	Chemicals known to cause cancer or reproductive toxicity Cobalt metal powder		BNA 2001
	Initial appearance on the list	07/01/92	
	Hazardous substance Cobalt, cobalt carbonyl, and cobalt hydrocarbonyl		BNA 2001
Delaware	Detection limit values for comparable fuel specification Cobalt		BNA 2001
	Concentration limit	4.6 mg/kg at 10,000 BTU/pound	
Florida	Toxic substance in the workplace Cobalt metal, dust, and fumes		BNA 2001
Georgia	Soil concentration Cobalt	20 mg/kg	BNA 2001
Illinois	Analytical parameters and required quantitation limits Cobalt		BNA 2001
	Water	50 µg/L	
	Soil	10 mg/kg	
	Method	6010A	
Indiana	Constituent subject to assessment monitoring Cobalt (total and dissolved)		BNA 2001
Maine	Screening standards for beneficial use Cobalt		BNA 2001
		5,875 mg/kg (dry weight)	
Michigan	Identification and listing of hazardous waste Cobalt		BNA 2001
		When in the form of 100 microns or less	

8. REGULATIONS AND ADVISORIES

Table 8-1. Regulations and Guidelines Applicable to Stable Cobalt (*continued*)

Agency	Description	Information	Reference
STATE (<i>cont.</i>)			
Minnesota	Hazardous substance Cobalt metal, dust, and fumes (as Co) Cobalt carbonyl (as Co) Cobalt, elemental and inorganic compounds (as Co) Cobalt hydrocarbonyl (as Co)		BNA 2001
Missouri	Hazardous constituent Cobalt (total)		BNA 2001
New Jersey	Hazardous substance Cobalt Cobalt carbonyl Cobalt compounds		BNA 2001
New York	Occupational lung disease Hard metal disease Cobalt		BNA 2001
Ohio	Toxic release inventory		BNA 2001
Oklahoma	Fertilizer labels and labeling; minimum percentage accepted for registration Cobalt	5x10 ⁻⁴ percent	BNA 2001
Oregon	Toxic substance Cobalt		BNA 2001
Pennsylvania	Hazardous substance Cobalt and cobalt fumes		BNA 2001

^aCobalt compounds: includes cobalt(II) carbonate, cobalt(II) chloride, cobalt(II) nitrate, cobalt(II) oxide, cobalt(II,III) oxide, cobalt(III) oxide, and cobalt(II) sulfate

^bGroup 2B: possibly carcinogenic to humans

^cA3: confirmed animal carcinogen with unknown relevance to humans

AAC = acceptable ambient concentrations; ACGIH = American Conference of Governmental Industrial Hygienists; ASIL = acceptable source impact level; BEI = biological exposure indices; BNA = Bureau of National Affairs; BPT = best practicable control technology; BTU = British thermal unit; CFR = Code of Federal Regulations; EL = emissions levels; EPA = Environmental Protection Agency; FDA = Food and Drug Administration; FSTRAC = Federal-State Toxicology and Risk Analysis Committee; HAP = hazardous air pollutant; IARC = International Agency for Research on Cancer; IDLH = immediately dangerous to life and health; IRIS = Integrated Risk Information System; MAC = maximum allowable concentration; NIOSH = National Institute for Occupational Safety and Health; NPDES = National Pollutant Discharge Elimination System; OEL = occupational exposure limit; OSHA = Occupational Safety and Health Administration; PEL = permissible exposure limit; PQL = practical quantitation limit; REL = recommended exposure limit; RfC = reference concentration; RfD = reference dose; STLC = soluble threshold limit concentrations; TAP = toxic air pollutant; TDS = total dissolved solids; TLV = threshold limit value; TRI = Toxic Release Inventory; TSCA = Toxic Substances Control Act; TTLC = total threshold limit concentrations; TWA = time-weighted averages; USC = United States Code

8. REGULATIONS AND ADVISORIES

Table 8-2. Regulations and Guidelines Applicable to Radioactive Cobalt

Agency	Description	Information	Reference
<u>INTERNATIONAL</u> Guidelines:			
IARC	Carcinogenicity classification	Group 1 (carcinogenic to humans)	IARC 2001b
ICRP	Occupational dose limits		ICRP 1991
	Effective dose	20 mSv per year, averaged over defined periods of 5 years	
	Annual equivalent dose		
	Lens of the eye	150 mSv	ICRP 1991
	Skin	500 mSv	
	Hands and feet	500 mSv	
	General population dose limits		ICRP 1991
	Effective dose	1 mSv in a year	
	Annual equivalent dose		
	Lens of eye	15 mSv	
	Skin	50 mSv	
WHO	Drinking water quality	No data	
<u>NATIONAL</u> Regulations and Guidelines:			
a. Air			
ACGIH	All radiation exposures must be kept as low as reasonably achievable		ACGIH 2000
	Effective dose		ACGIH 2000
	Any single year	50 mSv	
	Averaged over 5 years	20 mSv per year	
	Annual equivalent dose		
	Lens of the eye	150 mSv	
	Skin	500 mSv	
	Hands and feet	500 mSv	
	Embryo-fetus exposures once the pregnancy is known		
	Monthly equivalent dose	0.5 mSv	
	Dose to the surface of women's abdomen (lower trunk)	2 mSv for the remainder of the pregnancy	
	Intake of radionuclide	1/20 of the ALI	

8. REGULATIONS AND ADVISORIES

**Table 8-2. Regulations and Guidelines Applicable to Radioactive Cobalt
(continued)**

Agency	Description	Information		Reference
NATIONAL (cont.)				
DOE	Radiation standards			DOE 2000
	Inhalation DAC (μCi/mL)	Class W ^a	Class Y ^b	10CFR835
	⁵⁵ Co	1x10 ⁻⁶	1x10 ⁻⁶	Appendix A
	⁵⁶ Co	1x10 ⁻⁷	8x10 ⁻⁸	
	⁵⁷ Co	1x10 ⁻⁶	3x10 ⁻⁷	
	^{58m} Co	4x10 ⁻⁵	3x10 ⁻⁵	
	⁵⁸ Co	5x10 ⁻⁷	3x10 ⁻⁷	
	^{60m} Co	2x10 ⁻³	1x10 ⁻³	
	⁶⁰ Co	7x10 ⁻⁸	1x10 ⁻⁸	
	⁶¹ Co	3x10 ⁻⁵	2x10 ⁻⁵	
	^{62m} Co	7x10 ⁻⁵	7x10 ⁻⁵	
	Radiation standards			DOE 2000
	Air immersion DAC ^c (μCi/mL)			10CFR835
	^{60m} Co	1x10 ⁻³		Appendix C
EPA	Slope factors			EPA 1997b
	Inhalation (pCi)			
	⁵⁷ Co	2.88x10 ⁻¹²		
	^{58m} Co	8.90x10 ⁻¹⁴		
	⁵⁸ Co	5.17x10 ⁻¹²		
	⁶⁰ Co	6.88x10 ⁻¹¹		
NIOSH	REL	No data		
NRC	Effluent concentrations—air	ALI (μCi/mL)		NRC 2001k
	⁵⁵ Co			10CFR20
	Class W ^d	4x10 ⁻⁹		Appendix B
	Class Y ^e	4x10 ⁻⁹		Table 2
	⁵⁶ Co			
	Class W ^d	4x10 ⁻¹⁰		
	Class Y ^e	3x10 ⁻¹⁰		
	⁵⁷ Co			
	Class W ^d	4x10 ⁻⁹		
	Class Y ^e	9x10 ⁻¹⁰		
	⁵⁸ Co			
	Class W ^d	2x10 ⁻⁹		
	Class Y ^e	1x10 ⁻⁹		
	^{58m} Co			
	Class W ^d	1x10 ⁻⁷		
	Class Y ^e	9x10 ⁻⁸		
	⁶⁰ Co			
	Class W ^d	2x10 ⁻¹⁰		
	Class Y ^e	5x10 ⁻¹¹		
	^{60m} Co			
	Class W ^d	6x10 ⁻⁶		
	Class Y ^e	4x10 ⁻⁶		

8. REGULATIONS AND ADVISORIES

**Table 8-2. Regulations and Guidelines Applicable to Radioactive Cobalt
(continued)**

Agency	Description	Information		Reference
NATIONAL (cont.)				
NRC (cont.)	Effluent concentrations—air	ALI (μCi/mL)		NRC 2001k 10CFR20 Appendix B Table 2
	⁶¹ Co			
	Class W ^d	9x10 ⁻⁸		
	Class Y ^e	8x10 ⁻⁸		
	^{62m} Co			
	Class W ^d	2x10 ⁻⁷		
	Class Y ^e	2x10 ⁻⁷		NRC 2001k 10CFR20 Appendix B Table 1
	Occupational values			
	—inhalation	ALI (μCi)	DAC (μCi/mL)	
	⁵⁵ Co			
	Class W ^d	3x10 ³	1x10 ⁻⁶	
	Class Y ^e	3x10 ³	1x10 ⁻⁶	
	⁵⁶ Co			
	Class W ^d	3x10 ²	1x10 ⁻⁷	
	Class Y ^e	2x10 ²	8x10 ⁻⁸	
	⁵⁷ Co			
	Class W ^d	3x10 ³	1x10 ⁻⁶	
	Class Y ^e	7x10 ²	3x10 ⁻⁷	
	⁵⁸ Co			
	Class W ^d	1x10 ³	5x10 ⁻⁷	
	Class Y ^e	7x10 ²	3x10 ⁻⁷	
	^{58m} Co			
	Class W ^d	9x10 ⁴	4x10 ⁻⁵	
	Class Y ^e	6x10 ⁴	3x10 ⁻⁵	
	⁶⁰ Co			
	Class W ^d	2x10 ²	7x10 ⁻⁸	
	Class Y ^e	3x10 ¹	1x10 ⁻⁸	
	^{60m} Co			
	Class W ^d	4x10 ⁶	2x10 ⁻³	
	Class Y ^e	3x10 ⁶	1x10 ⁻³	
	⁶¹ Co			
	Class W ^d	6x10 ⁴	3x10 ⁻⁵	
	Class Y ^e	6x10 ⁴	2x10 ⁻⁵	
	^{62m} Co			
	Class W ^d	2x10 ⁵	7x10 ⁻⁵	
	Class Y ^e	2x10 ⁵	6x10 ⁻⁵	
OSHA	Safety and health regulations for construction—ionizing radiation			OSHA 2001e 29CFR1926.53
	Toxic and hazardous substances—ionizing radiation			OSHA 2001d 29CFR1910.1096

8. REGULATIONS AND ADVISORIES

**Table 8-2. Regulations and Guidelines Applicable to Radioactive Cobalt
(continued)**

Agency	Description	Information	Reference
<u>NATIONAL</u> (cont.)			
b. Water			
EPA	Drinking water standards		EPA 2000
	Beta particle and photon activity (formerly man-made radionuclides)		
	MCL	4 mrem	
	Cancer risk at 10^{-4}	4 mrem/year	
	Gross alpha particle activity		
	MCL	15 pCi/L	
	Cancer risk at 10^{-4}	15 pCi/L	
	Carcinogenic classification	Group A (human carcinogen)	
NRC	Effluent concentrations—water	<u>ALI (μCi/mL)</u>	NRC 2001k 10CFR20 Appendix B Table 2
	^{55}Co		
	Class W ^d	2×10^{-5}	
	^{56}Co		
	Class W ^d	6×10^{-6}	
	^{57}Co		
	Class W ^d	6×10^{-5}	
	^{58}Co		
	Class W ^d	2×10^{-5}	
	$^{58\text{m}}\text{Co}$		
	Class W ^d	8×10^{-4}	
	^{60}Co		
	Class W ^d	3×10^{-6}	
	$^{60\text{m}}\text{Co}$		
	Class W ^d	2×10^{-2}	
	^{61}Co		
	Class W ^d	3×10^{-4}	
	$^{62\text{m}}\text{Co}$		
	Class W ^d	7×10^{-4}	
	Releases to sewers—monthly average concentration	<u>ALI (μCi/mL)</u>	NRC 2001k 10CFR20 Appendix B Table 3
	^{55}Co		
	Class W ^d	2×10^{-4}	
	^{56}Co		
	Class W ^d	6×10^{-5}	
	^{57}Co		
	Class W ^d	6×10^{-4}	
	^{58}Co		
	Class W ^d	2×10^{-4}	
	$^{58\text{m}}\text{Co}$		
	Class W ^d	8×10^{-3}	
<u>NATIONAL</u> (cont.)			

8. REGULATIONS AND ADVISORIES

**Table 8-2. Regulations and Guidelines Applicable to Radioactive Cobalt
(continued)**

Agency	Description	Information		Reference
NRC (cont.)	Releases to sewers—monthly average concentration	<u>ALI (μCi/mL)</u>		NRC 2001k 10CFR20 Appendix B Table 3
	⁶⁰ Co			
	Class W ^d	3x10 ⁻⁵		
	^{60m} Co			
	Class W ^d	2x10 ⁻¹		
	⁶¹ Co			
	Class W ^d	3x10 ⁻³		
	^{62m} Co			
	Class W ^d	7x10 ⁻³		
c. Food and Drug				
FDA	Ionizing radiation for the treatment of poultry feed and poultry feed ingredients (energy sources)	Ionizing radiation is limited to gamma rays from sealed units of ⁶⁰ Co		FDA 1999 21CFR579.40
	Requirements regarding certain radioactive drugs— ⁵⁸ Co or ⁶⁰ Co	Labeled cyanocobalamin for use in intestinal absorption studies		FDA 2000d 21CFR310.503(c)
	Sources of radiation used for inspection of food, for inspection of packaged food, and for controlling food processing			FDA 2000c 21CFR179.21 (a)(2)
d. Other				
DOE	Values for establishing sealed radioactive source accountability and radioactive material posting and labeling requirements	<u>Activity (μCi)</u>		DOE 2000 10CFR835 Appendix E
	⁵⁶ Co	4.0x10 ¹		
	⁵⁷ Co	2.3x10 ²		
	⁵⁸ Co	1.4x10 ²		
	⁶⁰ Co	1.8x10 ¹		
DOT	Activity values (Ci)	<u>A₁</u>	<u>A₂</u>	DOT 2001a 49CFR173.435 Table
	⁵⁵ Co	13.5	13.5	
	⁵⁶ Co	8.11	8.11	
	⁵⁷ Co	216	216	
	^{58m} Co	1080	1080	
	⁵⁸ Co	27.0	27.0	
	⁶⁰ Co	10.8	10.8	

8. REGULATIONS AND ADVISORIES

**Table 8-2. Regulations and Guidelines Applicable to Radioactive Cobalt
(continued)**

Agency	Description	Information	Reference
<u>NATIONAL</u> (cont.)			
DOT	Superfund, reportable quantity (Ci)		DOT 2001b 49CFR172.101
	⁵⁵ Co	10	Appendix A
	⁵⁶ Co	10	Table 2
	⁵⁷ Co	100	
	⁵⁸ Co	10	
	^{58m} Co	1,000	
	⁶⁰ Co	10	
	^{60m} Co	1,000	
	⁶¹ Co	1,000	
	^{62m} Co	1,000	
EPA	RfC	No data	IRIS 2000
	RfD		
	Carcinogenicity classification		
	Annual possession quantities for environmental compliance (Ci/year)		EPA 2001a 40CFR61 Appendix E Table 1
		<u>Gas</u> <u>Liquid/ powder</u> <u>Solid</u>	
	⁵⁶ Co	2.3x10 ⁻⁶	2.3x10 ⁻³ 2.3
	⁵⁷ Co	1.8x10 ⁻²	1.8x10 ¹ 1.8x10 ⁴
	⁵⁸ Co	2.5x10 ⁻⁶	2.5x10 ⁻³ 2.5
	^{58m} Co	2.3x10 ⁻⁶	2.3x10 ⁻³ 2.3
	⁶⁰ Co	4.6x10 ⁻²	4.6x10 ¹ 4.6x10 ⁴
	^{60m} Co	7.0	7.0x10 ³ 7.0x10 ⁶
	⁶¹ Co	9.8x10 ⁻¹	9.8x10 ² 9.8x10 ⁵
	Concentration levels for environmental compliance (Ci/m ³)		EPA 2001a 40CFR61 Appendix E Table 2
	⁵⁶ Co	1.8x10 ⁻¹³	
	⁵⁷ Co	1.3x10 ⁻¹²	
	⁵⁸ Co	6.7x10 ⁻¹³	
	^{58m} Co	1.2x10 ⁻¹⁰	
	⁶⁰ Co	1.7x10 ⁻¹⁴	
	^{60m} Co	4.3x10 ⁻⁹	
	⁶¹ Co	4.5x10 ⁻⁹	
	Slope factors—ingestion (pCi)		EPA 1997b
	⁵⁷ Co	9.71x10 ⁻¹³	
	^{58m} Co	9.46x10 ⁻¹⁴	
	⁵⁸ Co	2.82x10 ⁻¹²	
	⁶⁰ Co	1.89x10 ⁻¹¹	
	Slope factors—soil for external exposure (year/pCi/g)		EPA 1997b
	⁵⁷ Co	2.07x10 ⁻⁷	
	^{58m} Co	3.21x10 ⁻¹¹	
	⁵⁸ Co	3.73x10 ⁻⁶	
	⁶⁰ Co	9.76x10 ⁻⁶	

NATIONAL (cont.)

8. REGULATIONS AND ADVISORIES

**Table 8-2. Regulations and Guidelines Applicable to Radioactive Cobalt
(continued)**

Agency	Description	Information		Reference
EPA	Superfund, reportable quantities (Ci)			EPA 2001i 40CFR302.4 Appendix B
	⁵⁵ Co	10		
	⁵⁶ Co	10		
	⁵⁷ Co	100		
	^{58m} Co	1,000		
	⁵⁸ Co	10		
	^{60m} Co	1,000		
	⁶⁰ Co	10		
	⁶¹ Co	1,000		
	^{62m} Co	1,000		
NCRP	Occupational exposures			NCRP1993
	Effective dose limits			
	Annual	50 mSv		
	Cummulative	10 mSv x age		
	Equivalent dose annual limits			
	Lens of eye	150 mSv		
	Skin, hands, and feet	500 mSv		
	Public exposures (annual)			
	Effective dose limits, continuous or frequent exposure	1 mSv		
	Effective dose limits, infrequent exposures	5 mSv		
	Equivalent dose limits			
	Lens of eye	15 mSv		
	Skin, hands, and feet	50 mSv		
	Embryo and fetus exposures (monthly)			
	Effective dose limit	0.5 mSv		
NRC	Activity values for radionuclides (Ci)	A ₁ _____	A ₂ _____	NRC 2001a 10CFR71
	⁵⁵ Co	13.5	13.5	
	⁵⁶ Co	8.11	8.11	
	⁵⁷ Co	216	216	
	^{58m} Co	1080	1080	
	⁵⁸ Co	27.0	27.0	
	⁶⁰ Co	10.8	10.8	

8. REGULATIONS AND ADVISORIES

**Table 8-2. Regulations and Guidelines Applicable to Radioactive Cobalt
(continued)**

Agency	Description	Information		Reference
NATIONAL (cont.)				
NRC	Byproduct material listing —exempt concentrations Liquid and solid concentration (μCi/mL ²)			NRC 2001e 10CFR30.70 Schedule A
	⁵⁷ C	5x10 ⁻³		
	⁵⁸ C	1x10 ⁻³		
	⁶⁰ C	5x10 ⁻⁴		
	Byproduct material listing (μCi)			NRC 2001b 10CFR30.71 Schedule B
	^{58m} Co	10		
	⁵⁸ Co	10		
	⁶⁰ Co	1		
	Byproduct material listing (Ci)	Column I ^f	Column II ^g	NRC 2001c 10CFR33.100 Schedule A
	^{58m} Co	100	1.0	
	⁵⁸ Co	1.0	0.01	
	⁶⁰ Co	0.1	1x10 ⁻⁴	
	Items containing byproduct material listing— ⁶⁰ Co (μCi)			NRC 2001d 10CFR30.15(a)(8)
	Electron tubes	1.0		
	Spark gap irradiators	1.0		
	Medical use— ⁶⁰ Co as a source for brachytherapy	As a sealed source in needles and applicator cells for topical, interstitial, and intracavitary treatment of cancer		NRC 2001h 10CFR35.400
	Occupational values—oral ingestion	ALI (μCi)		NRC 2001k 10CFR20 Appendix B Table 1
	⁵⁵ Co			
	Class W ^d	1x10 ³		
	⁵⁶ Co			
	Class W ^d	5x10 ²		
	Class Y ^e	4x10 ²		
	⁵⁷ Co			
	Class W ^d	8x10 ³		
	Class Y ^e	4x10 ³		
	⁵⁸ Co			
Class W ^d	2x10 ³			
Class Y ^e	1x10 ³			
^{58m} Co				
Class W ^d	6x10 ⁴			
⁶⁰ Co				
Class W ^d	5x10 ²			
Class Y ^e	2x10 ²			

8. REGULATIONS AND ADVISORIES

**Table 8-2. Regulations and Guidelines Applicable to Radioactive Cobalt
(continued)**

Agency	Description	Information	Reference
NATIONAL (cont.)			
NRC (cont.)	Occupational values—oral ingestion	<u>ALI (μCi)</u>	NRC 2001k 10CFR20 Appendix B Table 1
	^{60m} Co		
	Class W ^d	1x10 ⁶	
	St. wall	1x10 ⁶	
	⁶¹ Co		
	Class W ^d	2x10 ⁴	
	Class Y ^e	2x10 ⁴	NRC 2001g 10CFR30 Appendix B
	^{62m} Co		
	Class W ^d	5x10 ⁴	
	St. wall	4x10 ⁴	
	Quantities of radioactive material requiring labeling (μCi)		
	^{58m} Co	10	
	⁵⁸ Co	10	
	⁶⁰ Co	1	
	Quantities of licensed material requiring labeling (μCi)		NRC 2001i 10CFR20 Appendix C
	⁵⁵ Co	100	
	⁵⁶ Co	10	
	⁵⁷ Co	100	
	^{58m} Co	1,000	
	⁵⁸ Co	100	
	^{60m} Co	1,000	
	⁶⁰ Co	1	
	⁶¹ Co	1,000	
	^{62m} Co	1,000	
	Quantities of radioactive materials requiring need for an emergency plan		NRC 2001j 10CFR30.72 Schedule C
	Release fraction	0.001%	
	Quantity (Ci)	5,000	NRC 2001l 10CFR61.55
	Radioactive waste classification		
	Class A (Ci/m ³)		
	⁶⁰ Co	#700	NRC 2001f 10CFR20.2206 (a)(7)
	Reports of individual monitoring—processing or manufacturing for distribution, byproduct material in quantities exceeding		
	⁶⁰ Co (Ci)	1.0	

8. REGULATIONS AND ADVISORIES

**Table 8-2. Regulations and Guidelines Applicable to Radioactive Cobalt
(continued)**

Agency	Description	Information	Reference
<u>STATE</u>			
Regulations and Guidelines:			
a. Air			
Alabama	HAP—radionuclides		BNA 2001
California	HAP—radionuclides		BNA 2001
Hawaii	HAP—radionuclides		BNA 2001
Illinois	Toxic air contaminant—radionuclides		BNA 2001
Kansas	HAP—radionuclides		BNA 2001
Kentucky	HAP—radionuclides		BNA 2001
Minnesota	HAP—radionuclides		BNA 2001
Missouri	HAP—radionuclides		BNA 2001
Nebraska	HAP—radionuclides		BNA 2001
New York	HAP—radionuclides		BNA 2001
Rhode Island	HAP—radionuclides		BNA 2001
Wyoming	HAP—radionuclides		BNA 2001

^aClass W: refers to the approximate length of retention in the pulmonary region which is 10–100 days for this class

^bClass Y: refers to the approximate length of retention in the pulmonary region which is greater than 100 days for this class

^cAir immersion DAC values: based on a stochastic dose limit of 5 rems (0.05 Sv) per year or a nonstochastic (organ) dose limit of 50 rems (0.5 Sv) per year

^dClass W: all compounds except those given for Y

^eClass Y: oxides, hydroxides, halides, and nitrates

^fColumn I: gas concentration

^gColumn II: liquid and solid concentration

ACGIH = American Conference of Governmental Industrial Hygienists; ALI = annual limits on intake; BNA = Bureau of National Affairs; CFR = Code of Federal Regulations; DAC = derived air concentrations; DOE = Department of Energy; DOT = Department of Transportation; EPA = Environmental Protection Agency; FDA = Food and Drug Administration; IARC = International Agency for Research on Cancer; ICRP = International Commission on Radiological Protection; IRIS = Integrated Risk Information System; mSv = millisievert; NCRP = National Council on Radiation Protection; NIOSH = National Institute for Occupational Safety and Health; NRC = Nuclear Regulatory Commission; OSHA = Occupational Safety and Health Administration; PEL = permissible exposure limit; REL = recommended exposure limit; RfC = reference concentration; RfD = reference dose; TLV = threshold limit value; TWA = time-weighted averages; WHO = World Health Organization